DOCUMENT RESUME

ED 418 325 CE 076 292

AUTHOR Brown, Bettina Lankard
TITLE Using Problem-Solving Approaches in Vocational Education. Practice Application Brief.
INSTITUTION ERIC Clearinghouse on Adult, Career, and Vocational Education, Columbus, OH.
SPONS AGENCY Office of Educational Research and Improvement (ED), Washington, DC.
PUB DATE 1998-00-00
NOTE 4p.
CONTRACT RR93002001
PUB TYPE ERIC Publications (071)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS Agricultural Education; *Classroom Techniques; Educational Environment; Educational Practices; Educational Principles; Educational Theories; *Learning Processes; *Problem Solving; Secondary Education; Teaching Methods; Theory Practice Relationship; *Vocational Education
IDENTIFIERS *Problem Based Learning

ABSTRACT

The problem-solving approach to teaching and learning has proved especially useful in vocational education as a way to relate classroom learning to real-life situations or problems. The problem-solving method of teaching places the responsibility for learning on students. Educators and special reform groups in other subject areas refer to a process known as "problem-based learning," which is characterized by four critical features: engagement, inquiry, solution building, and reflection. For effective use of a problem-solving or problem-based approach to teaching and learning, teachers will have to alter three things: the balance of power in the classroom; the focus of attention; and their teaching skills. Reluctance to deviate from traditional teaching methods and incorporate a new teaching philosophy and practices is a major obstacle to adoption of the problem-solving approach to teaching. To implement a problem-solving approach, teachers must improve their interpersonal skills and group dynamics and be able to adapt instructional strategies, resources, and activities to promote students' development of basic skills, thinking skills, and personal qualities. Research has confirmed that, in agricultural education, the problem-solving approach is superior to the subject-matter approach as a way of improving student achievement. (Contains 15 references.) (MN)

Using Problem-Solving Approaches in Vocational Education Practice Application Brief

Bettina Lankard Brown

ERIC Clearinghouse on Adult, Career, and Vocational Education
Center on Education and Training for Employment
College of Education
The Ohio State University
1900 Kenny Road
Columbus, OH 43210-1090

ERIC Clearinghouse on Adult, Career, and Vocational Education

by Bettina Lankard Brown

1998

PRACTICE APPLICATION BRIEF

Using Problem-Solving Approaches in Vocational Education

The problem-solving approach to teaching and learning has evolved from the theories of John Dewey. It has been used especially in agricultural education as a way to relate classroom learning to real-life situations or problems. This *Brief* focuses on practice applications of problem solving in vocational education and their relationship to contextual learning environments.

Problem Solving for Teaching and Learning

Agricultural education has emphasized problem solving as a means of helping students to develop decision-making skills and teachers to alter their teaching methodology. The traditional method of problem solving for decision making reflects Dewey's five-step model for learning, expanded to six steps by Newcomb, McCracken, and Warmbrod (Straquadine and Egelund 1992): (1) identification of the problem situation: What is happening?; (2) definition of the problem: What must be done?; (3) search for information: What do we need to know?; (4) analysis of data: What are the important considerations?; (5) testing possible solutions: What will happen if this action is followed?, and (6) conclusion: What action is most promising?

The problem-solving method of teaching incorporates problem-solving activities, but places the responsibility for learning on the student. It requires teachers to move from the traditional instructional model to one that engages teachers and students as partners in learning, with the teacher functioning in the role of facilitator or coach rather than leader or all-knowing authority. It requires the use of problems that have real meaning to students, thus motivating them to reach a solution.

Educators and special reform groups in other subject areas refer to a process known as "problem-based learning," which has many similarities to the problem-solving approach. In problem-based instruction, all learning is done in context, within the learner's social environment. Learning occurs as students negotiate with others and evaluate the viability of each individual's understanding (Savery and Duffy 1995). Stepien and Gallagher (1993) discuss four critical features of problem-based learning:

1. *Engagement.* The problem raises concepts and principles relevant to the content area and addresses real issues that connect to the larger social context of the students' personal world.

2. *Inquiry.* The problem is ill-structured in that it has no one right answer. It often changes as more information is found. It requires exploration to define and refine the questions and ideas surrounding the problem.

3. *Solution building.* In problem-based learning, solutions are generated by the students who are the problem solvers; teachers are the coaches. As problem solvers, students engage in observation, inquiry, and investigation into hypotheses and issues, and they formulate conclusions that are consistent with the nature of the problem. As coaches, teachers promote learning by acting as models, demonstrating behaviors they want their students to adopt. They prompt students to take ownership of the problem and responsibility for its solution, and then fade into the background.

4. *Reflection.* Assessments, as authentic companions to the problem, offer a structure for reflection. They focus on the complexity of both the reasoning process and the subject-matter concepts within the problem, providing standards to act as benchmarks for thinking.

For effective use of a problem-solving or problem-based approach to teaching and learning, teachers will have to alter (1) the balance of power in the classroom, (2) the focus of attention, and (3) their teaching skills (Flowers 1992).

Issues Involved in the Problem-Solving Approach

Reluctance to deviate from traditional teaching methods and to learn and incorporate a new teaching philosophy and practices is a major obstacle to adoption of the problem-solving approach to teaching. Garton and Cano (1996) found that cooperating student agriculture teachers devoted less than 20% of instructional time to a problem-solving approach to teaching. Classroom teachers cooperating with the study spend most of their time on maintaining subject-matter interest; student teachers focused primarily on seeking information to resolve the problem.

Learning style is another factor thought to influence teacher use of problem-based instruction and student outcomes. Various research studies have found that "teachers of agriculture organized their lessons on a problem-solving basis, but did not follow through with active problem-solving teaching" (ibid., p. 48). Cano and Garton (1994) report that agriculture teachers with a "field-independent" (concrete rather than abstract) learning style were more apt to use problem solving in teaching. In a study of Illinois secondary students in agriculture, Dyer and Osborne (1996b) found that students classified as "field-independent" learners significantly increased their scores when taught using a problem-solving rather than subject-matter approach. Additionally, a study analyzing the effects of teaching approach across all learning styles—field-independent (concrete) learners, field-dependent (abstract) learners, and field-neutral (somewhere between concrete and abstract) learners—showed that field-neutral learners "scored significantly higher on achievement tests when taught in classes using the problem-solving approach" (Dyer and Osborne 1996a, p. 43). This approach was superior, however, only when relevant and meaningful problems were introduced (ibid.). The results from these and other studies of problem solving in agriculture education suggest that "each type of learning style benefited from instruction using the problem-solving approach" (p. 41).

Practical Applications of Problem-Solving Teaching and Learning

To implement a problem-solving approach, teachers need to improve their interpersonal skills and group dynamics; they need to be able to adapt instructional strategies, resources, and activities to promote students' development of basic skills, thinking skills, and personal qualities (Crunkilton 1992; Flowers 1992). Ackerman et al. (1997) suggest that problem-based activities be used to integrate technology into the instructional program, defining technology as "the application of knowledge to solve problems" (p. 7). They suggest that problem-based activities "provide the context for learning particular skills, use a team approach for reaching the best solu-

tion, and give a reason for using instructional technology" (ibid.). The technological problem-solving process requires students to "think critically, creatively, and resourcefully, while employing basic academic, technical, and social skills" (Penn and Williams 1996, p. 13).

Several applications of problem solving for teachers to use in adapting their instructional methods for a problem-solving approach to teaching are described here:

- The *Technology Projects for the Classroom and Teacher's Guide* offers 20 projects for technical education students that emphasize problem solving and hands-on learning. They engage students in the design and construction of models for such items as a hot air balloon, commuterscooter, geodesic dome, and others (Kaufman and Flowers 1996).

- Hedges (1996) presents 48 sample lesson plans for teaching critical thinking, problem solving, and academic and vocational competence. The lesson plans were developed by vocational and academic teachers and are drawn from a wide range of vocational program areas.

- The Oklahoma State Department of Vocational and Technical Education (1991) has developed a curriculum guide of technology learning activities targeted to students in grades 6-10. Topics include the problem-solving system, writing about problem solving, and related problem-solving activities.

- Ackerman et al. (1997) describe activities to enhance teacher and student awareness of the application of knowledge in problem solving. Teachers in a special workshop formed teams of 3-4 to "design a boat that would travel 3 feet as quickly as possible—building the model with consumable materials, testing and revising it, and presenting their solution to others" (p. 7). Through this experience, "teachers could see how the activity requires the teams to communicate both orally and in writing, to use the math skills of estimation and measurement, to apply science skills of buoyance and forces, to blend individual members' ideas into one idea, and to be excited about testing and revising the prototype to make it the best it can be" (p. 8).

- Penn and Williams (1996) use interdisciplinary problem-solving activities in Technology Learning Activities for the Cocoa Academy for Aerospace Technology (CAAT) program in Brevard County, Florida. The authors describe the CAAT system of learning, which is called "virtual learning." "In virtual learning, students and facilitators teach each other how to learn; the curriculum blends a range of disciplines, students learn in teams, facilitators teach in teams, all problem-solving activities have real-world relevancy; and authentic assessment is used to evaluate learning objectives" (pp. 17-18).

Advice to Teachers

The true focus of all educational endeavors is the student learner. Problem-based learning models must reflect the changing external environment of the workplace and society and include curriculum that has been designed to correlate with that environment. "Such activities encourage interdepartmental and interdisciplinary cultural milieus which create positive energies for the faculty, student, and business community" (West and Watson 1996, p. 3).

Savery and Duffy (1995) present a list of instructional principles that guide the practices of teaching and the design of learning environments (pp. 33-34). (1) anchor all learning activities to a larger task or problem; (2) support the learner in developing ownership for the overall problem or task; (3) design an authentic task, one in which the cognitive demands are consistent with the cognitive demands in the environment for which the learner is being prepared; (4) design the task and the learning environment to reflect the complexity of the environment they should be able to function in at the end of learning; (5) design the learning environment to support and challenge the learner's thinking; (6) encourage testing ideas against alternative views and alternative contexts; and (7) provide opportunity for and support reflection on both the content learned and the learning process.

The problem-solving approach to teaching has been used with success in many disciplines, e.g., medical, environmental, business, social science, and so forth. Crucial to its success in improving student achievement is the use of problems that are relevant and meaningful to students (Dyer and Osborne 1996a). The student is the focus of the teaching. The teacher's ability to use the problem-solving approach to teaching and the student's ability to respond to this approach may be linked to learning style. However, as noted in the agricultural education studies, the problem-solving approach to teaching is more effective in improving student achievement than the subject-matter approach.

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Developed with funding from the Office of Educational Research and Improvement, U.S. Department of Education, under contract No. RR93002007. Opinions expressed do not necessarily reflect the position or policies of OERI or the Department. *Practice Application Briefs* may be freely reproduced.

CENTER ON EDUCATION AND TRAINING FOR EMPLOYMENT
COLLEGE OF EDUCATION
THE OHIO STATE UNIVERSITY
1900 Kenny Road • Columbus, Ohio 43210-1090